CHAPTER 6: NON-QUANTIFIED BENEFITS

Introduction

This chapter describes analysis of Superfund program benefits that are not readily quantified due to gaps in data or a lack of suitable methods. The next section describes the relationship between property-based estimates and non-quantified benefits. Using the definitions from Chapter 1, the subsequent sections describe analyses of the benefits of Superfund that cannot be quantified, in turn: improved amenities, reduced material damage, additions to information and innovation, empowerment in solving problems of hazardous substance contamination, deterrence from further uncontrolled releases of hazardous substances, emergency preparedness, and benefits to the international community.

Relationship Between Property-Based Quantitative Benefits and Non-Quantified Benefits

Three benefit categories described here, *amenities*, *ecological*, and *deterrence*, may be partially accounted for by the property value-based benefit estimate presented in Chapter 4, and one category, *empowerment*, may be accounted for by the property value-based estimate almost entirely.[1] The amenities category is partly included in the property value-based benefit estimate because this benefit category includes the removal of unsightly facilities and perceived health risks. The latter may be particularly important to the pricing of homes near National Priorities List (NPL) sites, on which the property value-based benefit estimate relies (Gayer and Viscusi 2002). The deterrence category is partially included in the property value-based benefit estimate because people living near NPL sites may benefit more than the public at large from deterring further uncontrolled releases of hazardous substances.[2] Likewise, the ecological category may also be partially included in the property value-based benefits estimate because people living near NPL sites may benefit more than the public at large from the natural resource enhancements resulting from the Superfund program. The empowerment category is included in the property value-based benefit estimate in its entirety because people living near NPL sites make up the relevant communities and a major benefit of empowerment is the reduced uncertainty about health impacts from sites, likely leading to increased property values.

Although multiple benefit categories are included in the estimate of benefits calculated in Chapter 4, the property-based valuation methodology employed is unable to separate out the values for the different categories from one another. Thus, an individual estimate of any one benefit is not possible. In addition, health and ecological benefits are described in Chapter 5. Therefore, in order to better understand the benefits of the Superfund program, the seven benefits for which no estimate of the individual benefits is available are described in sections below. Brief definitions of these seven benefits are given in Table 6.1, which extracts the relevant categories from Table 1.2.

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[1] See Figure 1.2 and the associated discussion in Chapter 1.

[2] Any overlaps between the benefit estimate in Chapter 4 and categories that affect all Americans equally (e.g., Emergency Preparedness) are ignored.

Table 6.1. Brief Definitions of Non-Quantified Benefits

Benefit	Definition
Fundamental	
Amenities	Any feature of a place, object, or experience that enhances its attractiveness and increases the user's satisfaction, but is not essential to the place, object, or experience. In the context of Superfund, amenities include the removal of unsightly structures, the reuse of abandoned property, the avoidance of the stigma associated with contamination, and the reduction of perceived health risks from uncontrolled releases of hazardous substances.
Materials	The reduction of risk and perceived risk associated with non-residential (i.e., commercial and industrial) properties, and the ensuing ability and willingness of the business and financial community to use these properties.
Embedded	
Empowerment	The ability of people who live near Superfund sites (especially NPL sites) to learn about the site(s) of interest, have questions about the site(s) answered, participate in decision-making associated with the site(s), and hold the relevant organizations accountable.
Deterrence	Incentives for firms and individuals that may create or use hazardous substances to handle and dispose of them properly and to avoid uncontrolled releases to the environment.
Emergency Preparedness	The knowledge, skills, organization, and technologies necessary to limit harm to human health and the environment following disasters involving the release of hazardous substances. Includes preparation for natural disasters, homeland security measures, and similar activities.
Information and Innovation	Increases in knowledge and technical capabilities created as a result of research, development, and deployment supported by the Superfund program. This includes both basic scientific research as well as efforts to develop and build experience and confidence in new technologies.
International Benefits	Any benefits from any of the other benefit categories that accrue to people or organizations outside of the United States. These benefits are generally coordinated with the State Department and often involve overseas response actions or training.

Amenities

The *amenities* benefit of Superfund is associated with the removal of unsightly, often abandoned, facilities, as well as the psychological benefits associated with reducing the uncertainty and fear of unknown risks that might exist at nearby hazardous substance facilities. Even in cases where there may be little health risk, psychometric research has shown that individuals can experience genuine discomfort and anxiety if exposed to risks that are dreadful, imposed by others, out of their control, hard to understand, or have other features that hazardous substance sites are likely to have (Slovic et al. 1979; Slovic 1987). These effects can lead to larger, more permanent damages, sometimes called stigma (Gregory et al. 1995; Satterfield et al. 2001). Thus, reduction in perceived risks is likely an important part of the amenities benefit.

It is important to consider if and how the *amenities* benefit would appear in the policy case (i.e., no Superfund program). Without the Superfund program, far fewer responses to uncontrolled releases of hazardous substances would have occurred, and those that did would most likely have taken longer and been less stringent (because without Superfund neither the liability provisions that lead to private funds for response actions nor federal support for response actions would be available). In addition, without Superfund, uncertainties about the extent and impacts of hazardous substances would most likely be far larger and thus the perceived risks would be even larger. (This last effect blurs the distinction somewhat between the *amenities* benefit and the *information and innovation* benefit discussed later.)

Materials

Overview

In terms of avoiding or reversing material damages, the Superfund program often helps convert unusable commercial and industrial properties back into productive real estate. In many cases, the avoided damage is associated with removal of both uncertainty about the presence of hazardous substances and with uncertainty about the cost of restoring the site to a usable condition.

The analysis of residences near NPL sites discussed in detail in Chapter 3 showed that that single-family, owner-occupied, detached homes are the largest residence type, representing 47% of all residences, and that rental single-family detached homes accounted for another 8%. Other owner-occupied residences (duplexes, condominiums, etc.) account for 11%, and multi-family rental housing for 33%. Some studies include condominiums in their data, and the effect on prices for these properties are similar to those for other types (Hite et al. 2001; Ihlanfeldt and Taylor 2004).

Most of the literature on property values and hazardous waste sites, including both theoretical discussions and empirical studies, focuses on residential properties. At the same time, some literature by scholars and practitioners in the real estate field has addressed the impact of hazardous waste sites on commercial and industrial (C&I) properties. In addition, a few recent empirical studies using property-based[3] price theory to evaluate the impacts of C&I property have been published recently. This section reviews the existing literature and synthesizes it. In addition, it reflects the experience of the authors of the SBA in real estate and hazardous waste/brownfields cleanups.

Theory

The theory of hedonic valuation begins with the observation that some products (or commodities) can be differentiated by the amounts of various characteristics they embody (Rosen 1974; Freeman 1993). The consumers of different types of commodities derive utility from the characteristics of the commodities, while producers or sellers incur costs that are dependent on the types of commodities they provide. Hedonic price theory assumes a competitive market in equilibrium and assumes perfect information and zero transaction costs (Palmquist 1992; McConnell 1993). Most applications of property-based price theory to real estate have considered only residential properties (Boyle and Kiel 2001). Many of the most recent and most insightful property-based studies focus on the role of information in changing perceived risk near hazardous waste sites over time (Kiel 1995; McMillen and Thorsnes 2000; Gayer et al. 2002). There are a variety of factors that make it harder to determine condition-specific (proximity to hazardous waste) effects on commercial and industrial property values than it is to determine the effect that these conditions have on residential property values. There

[3] Throughout this study, property-based valuation refers to the economic concept of hedonic based valuation of housing markets as discussed in Chapter 10 of Champ et al. The term property-based valuation is used to facilitate common understanding by non-economists.

are significant differences between residential and C&I property markets, including market size, relevant amenities, structural economic changes, and differences in financing practices.

Market Size

There is a dramatically larger number of willing buyers, sellers, and transactions in the residential market than in either the commercial or industrial markets. (It is important to note that the difference between commercial and industrial is also significant – there are dramatically more commercial transactions than there are industrial). In addition to the much smaller number of properties, individual commercial and industrial properties tend to change hands with less frequency than the average residential property. Thus the quantity and quality of data that would be analyzed are not likely to be as good for C&I properties.

Relevant Amenities

There is a far greater range of amenities affecting price in the residential market compared to commercial properties, and more in commercial than industrial. Residential property owners may be affected by a wide array of factors when purchasing a property, such as school district, views, neighborhood, room sizes, lot size, charm, distance to work, house style, and so forth. While commercial property buyers may consider a number of factors, there are usually one or two factors that far outweigh the rest. The owners of a retail establishment, for instance, may not like the color of the awnings or the size of the bathroom, but they will locate where the most traffic appropriate for their business exists. With an industrial property, easy access to resources and markets will be the primary amenity sought. Quick access to airports is often a key amenity for business locations.

Structural Economic Changes

The resources important to industry, the location of markets, and the transportation networks that we rely on have all changed significantly over the past twenty years and extraordinarily over the past fifty years. Many Superfund sites are located in areas where resources important to yesterday's industries (e.g., mineral deposits and mining companies) and access to yesterday's transportation networks (e.g., river transportation for heavy iron ore, coke and steel) were advantageous. These locations are no longer valuable to today's products and markets. For instance, today's economy in Pittsburgh, Pennsylvania is dominated by education, government, health care, and high tech, none of which need the rivers for transportation. Thus it may be difficult to determine how much of an impact proximity to hazardous waste is having on property values as opposed to general economic decline of a particular industry. These sorts of structural changes need to be considered in the specification of any property-based model. They also need to be considered if the results from one area are to be generalized to another, where different patterns of change may dominate. For instance, estimates based on data from Atlanta may not be appropriate for Pittsburgh, due to vast differences in the patterns of economic growth in these two cities.

Sites on the NPL are often in areas of general economic decline that feature a number of bankruptcies that have nothing to do with the presence of hazardous waste sites. Indeed, bankruptcy may tend to be a cause of NPL status rather than a result. Solvent firms can take steps to avoid NPL listing, including site cleanups and negotiations to avoid listing. The numerous sites that are part of state voluntary programs for hazardous waste cleanup give some evidence of this.

Financing Practice

There are numerous differences between the practices for financing a residential property and a C&I property. One important factor is that due diligence (background investigation) requirements for C&I properties are much greater. Importantly, the concern is typically not the health or environmental risk associated with any contamination, but the cost of the associated liability, which may be far greater. Further, CERCLA's stringent liability provisions can amplify this risk tremendously, leading to concerns by lenders about the ability of borrowers to repay loans at all. This is a major difference between residential and C&I markets that would make the interpretation of property-based studies quite different for the two markets. The lack of financial institutions willing to finance industrial properties with potential contamination can have a dramatic effect on property values. Of course, firms may have recourses other than bank financing (e.g., debt or equity sales), but the amount any organization can afford to pay for a property diminishes dramatically if the purchase (investment) cannot be leveraged. Because the market for residential mortgages is so much larger than that for C&I real estate, and is collateralized by the Federal Home Loan Mortgage Corporation (Freddie Mac), among others, the risks associated with contaminated residences is much less on a proportional basis and much more easily managed.

Other Literature

Table 6.2 briefly describes some of the relevant studies. There are some inconsistencies among various authors. Some papers are anecdotal or theoretical, but five are empirical studies relevant to the cleanup of hazardous waste sites. These are discussed below, in chronological order.

Page and Rabinowitz compared six commercial real estate sites in Pittsburgh, Santa Fe, and Milwaukee with seven residential areas (818 homes), all in areas of ground water contamination (1993). They found significant property value effects in the commercial real estate market, with losses of 10%-50% and some projects simply being put on hold. They note an extreme example: In Wichita, Kansas, eight square miles of ground water contamination in the central business district reduced the assessed value of properties (which accounted for 7% of the city's tax base) by 40%, representing a loss of almost three percent of the city's property tax revenue.

Howland collected data on 480 industrial parcels (1,072 acres) in an area that included at least four closed hazardous waste sites (one of which was on the NPL) (2000). Howland is principally concerned with whether hazardous waste contamination accounts *entirely* for abandoned land use, as suggested by common perceptions and some earlier authors (Patchin 1988; Rinaldi 1991). Howland evaluates the impact of hazardous waste contamination on the supply and demand for industrial land, and finds that "in locations where there is an active market for industrial land, contamination – at least of the sort that exists in Southeast Baltimore – is not a [complete] deterrent to land purchase and reuse. The market operates just as economic theory would suggest: Land sellers can and do lower prices sufficiently to compensate for the costs of remediation and the perceived risks of future cleanup." In the cases she examines, Howland finds that a 55% discount on contaminated land relative to clean sites is sufficient, on average, to enable sales.

Schoenbaum conducted a similar study, also in Baltimore, in order to examine the validity of the assumption underlying brownfields legislation that real or potential environmental contamination systematically affects land use and economic value (2002). For various reasons, sale prices could not be used in this study, so assessed values were employed. Schoenbaum discusses the conceptual framework for urban land value and development and appears to take into consideration many of the theoretical issues discussed above. She states, “No systematic relationships were found between environmental contamination, on the one hand, and either land values (assessed), land vacancy, property turnover, or changes in economic development.” However, Schoenbaum goes on to say that this “does not mean that environmental contamination is irrelevant. Indeed, numerous case studies have shown that it can be a substantial obstacle, and that removal of that obstacle by brownfields policies can lead to redevelopment of contaminated parcels. But if pollution alone does not cause vacancy and under use, as this study suggests, then brownfields legislation alone will presumably fail to solve the problem.”

More recently, Howland examines three case studies in detail, all of which are in Baltimore to control for structural economic conditions and policies (2003). This study finds that somewhat different factors are important to redevelopment than did an earlier study that used survey and interview data (Meyer and Lyons 2000). Key factors include strong market demand for the project, retention of commercial or industrial use (instead of a switch to residential), higher levels of contamination, a novice developer (for this type of property), and bureaucratic delays.

A detailed property-based study of C&I properties in Fulton County, Georgia (which includes Atlanta) was recently completed by Ihlanfeldt and Taylor (2004). They focused on non-NPL sites and argued that these tended to have smaller effects on property than do NPL sites. They specify multiple property-based valuation models and look at various categories of C&I property. Overall, they find that for all C&I properties an approximately 10% decline in value is associated with proximity to (within 2 miles of) non-NPL hazardous waste sites, or as much as $1 billion in total impacts. This finding suggests that private cost sharing and tax-increment financing may be justified.

It is important to consider if and how the *materials* benefit would appear in the policy case (i.e., no Superfund program). Similar to other benefit categories, the fact that without Superfund fewer responses would occur and uncertainties associated with toxic contamination of real property would be greater suggests that a large fraction of the materials benefit should be assigned to Superfund.

Table 6.2. Literature Relevant to Commercial and Industrial (C&I) Properties

Paper	Site	Property Data	Conclusions
(Patchin 1988)	n/a	Anecdotal: no specific data reported	Seriously contaminated properties are unmarketable. Contaminated property still able to be utilized as originally intended may have moderate decline whereas one no longer possible for original use may see total loss. No chance of financing for a seriously contaminated property.
(Rinaldi 1991)	n/a	Anecdotal: no specific data reported	Views contamination as a loss in value (depreciation) from value as if uncontaminated. Believes properties generally cannot be sold, rented, or conveyed in contaminated condition.
(Page and Rabinowitz 1993)	Pittsburgh; Milwaukee; Commerce Center, CA	Case studies on effect of groundwater contamination on C&I and residential properties	range of 10-50% decrease in property value - found no effect on residential properties
(Roddewig 1996)	n/a	Ten critical inquiries that every real estate appraiser should bear in mind regarding contaminated properties	1. what type of risk is present, 2. how do five critical cycles affect perceptions of risk, 3. environmental site assessment, 4. designated federal or state SF site, 5. approved or completed remediation plans, 6. contamination's effect on current use, 7. contamination's effect on surrounding uses, 8. government programs to offset risk, 9. guarantee or insurance programs for buyers, 10. how are comparable sales
(Syms 1997)	n/a	n/a	Comparative psychometrics
(Roddewig 1999)	n/a	n/a	Sets up a scorecard system for classifying risk and stigma associated w/ contaminated sites. "Using sales of contaminated properties as direct evidence of the value of property after considering contamination is often difficult. This is because of the small number of such transactions and the problems involved in making proper adjustments to reflect distinguishing factors"
(Meyer and Lyons 2000)	n/a	None - survey and interview data from entrepreneurs who develop contaminated properties - called Environmental Merchant Bankers	<u>Preferred characteristics</u>: heavy contamination, high value location, private ownership, unusual pollution, large parcel size, high returns. <u>Obstacles:</u> competitive bidding, stigma, redevelopment restrictions
(Boyd et al. 1996)	n/a	Theoretical paper with no applied data.	Seeks to "develop a model to examine how CERCLA liability can modify the terms of trade and incentives for real estate redevelopment." Conclusion: "Land use inefficiency arises due to information asymmetries between buyers and sellers of potentially polluted property."

Table 6.2. (Continued)

Paper	Site	Property Data	Conclusions
(Howland 2000)	Canton/SE industrial area of Baltimore.	Property owner interviews and census bureau GIS info	The average price per acre of sites known to be contaminated was 55% of that for clean sites. Where there is an active market for industrial land, contamination is not a deterrent to land purchase and reuse. Sellers lower prices sufficiently to compensate for remediation & perceived risks of future cleanup costs. Little support for idea that owners hoard parcels to avoid cleanup costs.
(Schoenbaum 2002)	Two sq. mile area in industrially zoned Fairfield - southern edge of Baltimore	Deeds & tax assessment records at two-year intervals from 1963-1999, US Census data, field inspections, current and historical aerial photos, telephone directories, personal interviews, and secondary sources.	Suggest that contamination alone doesn't account for existence of vacant or underused industrial properties in central cities. Evidence suggests that the property market learned to cope with regulatory & liability problems posed by real or potential pollution.
(Howland 2003)	Baltimore - Three development projects:	Three case studies looking at environmental history and redevelopment history. Looks at success and failures in terms of cleanup and development	1. need a certain market for final product, 2. switch from industrial to residential increases project risks and costs, 3. character and level of contamination affects risk and probability of success
(Ihlanfeldt and Taylor 2004)	Fulton County, GA (31sites in GAEPD haz site inventory; 23 non-NPL sites in CERCLIS; 96 NFRAP sites)	Estimate property-based price models using property transactions data from Commercial Vendor and Census bureau. Used characteristics by tax roll, GIS location, and census location. Property types: apartment, office, retail, industrial, vacant	Found effect up to 1.5-2.0 miles. The total value loss per total assessed value is 10%; thought to be an upper bound since assessed values tend to underestimate market prices since assessor's estimated lag behind changes in actual market prices: apartment 18%, office 13%, retail 7%, industrial 5%, vacant 19%

Empowerment

To ensure that local citizens are knowledgeable about and involved in Superfund-related decisions that affect their communities, EPA conducts formal and informal stakeholder involvement and public participation activities. Public participation activities and processes allow the public to participate in Agency actions and hold the Agency accountable for its decisions.

Among the clearest examples of how the Superfund program empowers communities is the Technical Assistance Grant (TAG) program. TAGs, which were authorized under the Superfund Amendments and Reauthorization Act (SARA), provide money to help local communities participate in decisions at eligible Superfund sites (NPL and proposed NPL sites). TAG funds, generally up to $50,000, can be used to pay a technical advisor to review site documents, interpret or explain technical information, and help a community communicate its concerns so that they and decision makers are better informed on site specific issues (U.S. Environmental Protection Agency 2000b).

In addition to TAGs, the Superfund program has other programs to empower communities in response actions. The Technical Outreach Services to Communities (TOSC) project provides services similar to those covered by TAGs and is available to communities that do not qualify for TAGs. It has provided independent university-based scientific and engineering expertise to 115 communities dealing with hazardous substance contamination questions. A community can also participate in response decisions through a Superfund Community Advisory Group (CAG). These are made up of community members and can serve as the focal point for the exchange of information among the local community, EPA, the state regulatory agency, and other pertinent federal agencies involved in cleanup of a Superfund site (Office of Solid Waste and Emergency Response 1998).[4]

EPA maintains a substantial outreach and information effort for sites under the Superfund program, which includes not only NPL sites but also every site assessed by the program. The Superfund web site allows access to some CERCLIS-based information on every site discovered. Preliminary assessment and site inspection reports, typically available at the regional offices, describe each site and provide information about the substances present, potential exposure pathways, and any known exposures. For NPL sites, there are dockets and local information repositories, and typically there are substantial outreach efforts. The program also provides information to the public on how to avoid exposures where sites have not yet been addressed. For example, the program might help disseminate fish consumption advisories.

The Superfund program also uses its community outreach mechanisms to create partnerships with local businesses, community organizations, and other federal agencies to develop and support job training. The Superfund Job Training Initiative (SuperJTI) supports job training programs in communities affected by nearby Superfund sites. Because EPA by law is unable to fund SuperJTI activities, its role is mainly advisory. EPA is responsible for deciding which sites are good candidates for SuperJTI, providing program guidance at the national level, and coordinating local SuperJTI participants. At its most basic level, the program provides outreach and organizational support to link a community with the National Institute of Environmental Health Sciences (NIEHS) Minority Worker Training Program, which may provide grant funding for life skills and hazardous waste training. SuperJTI benefits residents by increasing their understanding of the cleanup efforts in their communities and providing them with marketable skills, which will enhance their employment potential.[5]

Some benefits of the Superfund community empowerment activities are very likely indirectly captured by the property-based analysis of Chapter 4. By providing communities with the best scientific and technical information about nearby sites, the likelihood of stigma effects on property values is reduced. That information might include, for example, schedules for response

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[4] See www.epa.gov/superfund/tools/cag/index.htm and www.toscprogram.org/tosc-overview.html for more information.

[5] See www.epa.gov/superfund/tools/sfjti/index.htm and www.niehs.nih.gov/wetp/program/brownfields.htm for more information

actions, allowing the public to make informed decisions on how best to avoid disruption of their activities. It might include information about the likelihood of health impacts (or the likely absence of health impacts), thus allowing property purchasers and sellers to make better informed property transaction decisions. The availability of TAGs and the TOSC to communities enhances the effects of the information dissemination; through these, communities can access independent experts to evaluate EPA's statements, thereby leading to greater credibility for the Agency.

The site-specific information created by the Agency for Toxic Substances and Disease Registry (ATSDR) also contributes to the empowerment benefit. Due to the high level of concern about health impacts of uncontrolled hazardous substance releases, Congress created ATSDR as part of CERCLA in order to implement the statute's health-related provisions. ATSDR is an advisory agency that (among other tasks) makes recommendations for actions at specific sites or in response to specific issues, but cannot mandate actions (Agency for Toxic Substances and Disease Registry 2003c, 2004).[6] ATSDR's responsibilities include:

- Preventing or reducing exposure to hazardous substances and the illnesses that result from these exposures;
- Assessing the presence and nature of health hazards at NPL and other hazardous sites (Agency for Toxic Substances and Disease Registry 2003a);
- Expanding the available knowledge about health effects from exposure to hazardous substances;
- Assisting EPA in determining which substances should be regulated and the levels at which substances may pose a threat to human health;
- Establishing and maintaining toxicological databases (Agency for Toxic Substances and Disease Registry 2003b); and
- Educating physicians and other medical professionals about the signs and treatment of hazardous-substance-related illnesses.[7]

The role of ATSDR, therefore, is to study a site or scientific issue, develop and provide information, educate the community (both the physical community around a site and the larger scientific and medical community), and make recommendations. Each of these actions can have significant benefits for communities affected by hazardous substances and for the scientists and doctors who work with these affected communities. ATSDR is required to conduct a public health assessment (PHA) of any site on or proposed to the NPL. Additionally, ATSDR can assist at non-NPL sites, including performing a PHA, Public Health Advisory, health consultation, exposure investigation, and medical monitoring program (all discussed below), if requested by EPA, another federal agency, state or local governments, or citizens. On the basis of these

[6] In this sentence, "community" can mean both the community proximate to specific sites, as well as the larger scientific and medical community, although only the former is associated with the empowerment benefit. Benefits resulting from information that flows to the larger scientific and medical community is different and is discussed as part of the information and innovation benefit category. ATSDR is discussed in more detail there as well.

[7] From the ATSDR's website, Background and Congressional Mandates: www.atsdr.cdc.gov/congress.html.

community health studies, ATSDR can identify risks to communities and the level of risk posed by a site, as well as actions recommended to interdict pathways of exposure.

ATSDR reports that "more than half" of the sites at which it works are not on the NPL.[8] Public Health Assessments can be requested by any individual citizen or group of citizens concerned about potential health effects of a contaminated site. When ATSDR is petitioned to investigate a site, a research team is formed to gather information, including visiting the site and talking with community members. This information is then presented to a committee, which determines what action, if any, ATSDR should take at the site. All of the decisions of ATSDR are documented and provided to the community.[9]

In addition to PHAs, ATSDR performs Health Consultations (HCs) to provide "advice on a specific public health issue related to real or possible human exposure to toxic material."[10] An HC is less in-depth than a Public Health Assessment and acts as a quick gauge of potential risk. HCs take into account concentrations of hazardous substances and their potential exposure routes to humans, as well as the potential health risks of these substances or other dangers posed by the site. An HC can lead to more intensive ATSDR involvement, such as a Public Health Assessment or a Public Health Advisory. ATSDR provides approximately 1,000 Health Consultations per year.

A Public Health Advisory allows ATSDR "to respond quickly when hazardous substances released into the environment pose an immediate and significant danger to people's health."[11] Based on ATSDR's study of a community potentially exposed to a hazardous site, through a Health Consultation or a Public Health Assessment, ATSDR can issue a Public Health Advisory notice directly to EPA's administrator, thereby alerting EPA and other government agencies that a public health threat exists. ATSDR can then work with involved agencies to determine protective actions and see that they are implemented.

In addition to PHAs and HCs, ATSDR can perform exposure investigations and medical monitoring. Exposure investigations are used to "develop better characterization of past, current, and possible future human exposures to hazardous substances in the environment and to evaluate existing and possible health effects related to those exposures."[12] Exposure investigations use bio-medical testing (such as blood or urine samples), environmental testing, and computer modeling to determine the potential health risks at a site. Medical monitoring includes conducting health surveillance for "populations at significant increased risk of adverse health effects as a result of exposure to hazardous substances." According to the recent Public Health Assessments and Advisories of ATSDR, "more than 3 million people were exposed or potentially exposed to contaminants at Superfund sites investigated; … about 4% of the sites

[8] ATSDR Frequently Asked Questions webpage: www.atsdr.cdc.gov/faq/.

[9] ATSDR Petitioned Public Health Assessment webpage: http://www.atsdr.cdc.gov/COM/petition.html#3.

[10] ATSDR Health Consultation webpage: www.atsdr.cdc.gov/HAC/consult.html.

[11] ATSDR Public Health Advisory webpage: www.atsdr.cdc.gov/HAC/healthad.html.

[12] ATSDR Exposure Investigation webpage: www.atsdr.cdc.gov/HAC/expinfaq.html.

were categorized as urgent public (human) health hazards and 49% of the sites as public (human) health hazards."[13]

It is important to consider if and how the *empowerment* benefit would appear in the policy case (i.e., no Superfund program). Without the Superfund program, far fewer responses to uncontrolled releases of hazardous substances would have occurred; therefore, many communities would likely be dealing with a much worse problem: ongoing (and possibly worsening) contamination by hazardous substances without outside assistance. For this reason, and because essentially all activities designed to empower the community are attributable to the Superfund program, it seems realistic that all of the empowerment benefit can be attributed to the Superfund program.

Deterrence

Overview

The liability provisions of CERCLA, along with information provisions such as the Toxics Release Inventory (TRI) and Emergency Planning and Community Right-To-Know Act (EPCRA) provide opportunities for the Superfund program to act as a deterrent to possible hazardous releases.[14]

Many CERCLA responses involve the enforcement of CERCLA's liability provisions, in which EPA seeks to identify the potentially responsible parties (PRPs), those individuals or organizations responsible for creating or contributing to a hazardous waste site. CERCLA's two basic liability provisions permit EPA to either compel a PRP to abate an endangerment to public health, welfare, or the environment, or to recover the costs of EPA's response. This latter provision, plus the existence of the Trust Fund has allowed for timely response to minimize risks. The law also provides for citizen suits to enforce CERCLA's provisions (Section 310), and it provides authority for federal agencies, states, and tribes to bring actions for damages to natural resources (Section 107), as discussed in Chapter 5.

Liability can extend to site owners, facility operators, waste transporters, or anyone who generates hazardous substances that contaminate other sites. This liability is strict, joint, and several, with no requirement that a PRP's hazardous substance be the sole cause for the need for a response action. Legal proof of negligence is not required, and conducting activities consistent with standard industry practices is not considered an adequate defense. The original draft of CERCLA contained no statute of limitations. This was altered in 1986 with SARA's inclusion of limits on recovery actions, natural resource damages, and contribution actions.

Also known as Title III of SARA, the 1986 Emergency Planning and Community Right-to-Know Act (EPCRA) establishes requirements for federal, state, and local governments and industry regarding emergency planning and "Community Right-to-Know" reporting on hazardous and toxic chemicals. Section 313 of EPCRA requires EPA to establish an inventory of routine toxic chemical emissions from certain facilities subject to the Act's reporting requirements. These

[13] ATSDR's Medical Monitoring webpage: www.atsdr.cdc.gov/COM/medmon.html.

[14] TRI and EPCRA have benefits that flow to both neighbors and non-neighbors of NPL sites; therefore, this benefit is included here rather than in Empowerment.

facilities are required to complete a Toxics Release Inventory (TRI) form for specified chemicals (Office of Information and Analysis 2004). The intent of these forms is to capture the extent and nature of chemical releases from the preceding calendar year. The TRI is a database and provides no direct requirements for companies to lower their emissions; they simply need to report their emission levels (although many TRI chemicals are also regulated under the Clean Air Act).

EPA compiles the TRI data each year and makes it available to the public through several data access tools, including the TRI Explorer and Envirofacts. There are other organizations which also make the data available to the public through their own data tools. For instance, OMB Watch operates a tool called "RTKNet,"[15] Environmental Defense has developed a database tool called "Scorecard," and the National Partnership for Environmental Priorities uses TRI data to identify facilities that may present pollution prevention opportunities.[16]

Reduced Emission Levels and Reduced Health Impacts

A quick glance at some TRI data indicates that releases to the environment of the TRI chemicals tracked since 1988 have decreased more than 50 percent while the economy has approximately doubled in size, an achievement due in part to the availability of information (Khanna et al. 1998). This translates to hundreds of billions of pounds of toxic chemicals no longer released to the environment and no longer serving as an exposure hazard to potentially receptive populations.

While the primary purpose of TRI is to inform about chemical hazards, release estimates alone are not sufficient to determine exposure or to calculate potential adverse risks to human health and the environment. Human health impacts are not directly related to emission releases, but rather to the exposures or inhaled doses. A chemical's release rate, toxicity, and environmental fate, as well as local meteorology and the proximity of nearby communities to the release must be considered when assessing exposure changes and their impact on human health (Office of Information and Analysis 2004). TRI contains no information or data about potential exposure to toxic chemicals or the potential for health or environmental effects if exposed. Therefore, there is limited ability to assess the extent of human health benefits that may have resulted from reductions in TRI-listed chemicals. In addition, only a small portion of industries releasing chemicals into the environment are required by EPA to submit the TRI report and the list of chemicals is not inclusive of all chemicals known to have significant public health or environmental impact (Harrison and Antweiler 2003).

Improved Corporate Environmental Management

The public availability of the TRI data has led many corporations to commit publicly to voluntary emissions reductions. One well-known pledge was Monsanto's 1989 commitment to reduce its worldwide air emissions of a subset of TRI chemicals by 90 percent by 1992 (Office of Information and Analysis 2002). Boeing has used TRI data to track the company's progress in managing its hazardous emissions. The company states that it uses TRI-based information as

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[15] www.rtknet.org/. accessed July 1, 2004.

[16] See www.epa.gov/epaoswer/hazwaste/minimize/partnership.htm for more information. Accessed July 8, 2004.

a means for identifying and investing in pollution prevention programs that can supplement the company's current emission reduction programs.[17]

The TRI can help to develop environmental strategies and identify priorities by providing baseline information about the pollution burden and to identify priority areas for the introduction of technologies for cleaner production and provide indicators for monitoring the success of such approaches. A number of state and local voluntary emissions reduction programs have sprung up since the beginning of TRI reporting. Many of these programs use TRI data to set emission reduction goals and to track progress in meeting those goals (Office of Information and Analysis 2003).

For some industries, the creation of the TRI marked the first time that company managers and operators could look closely at the quantity of chemicals being released from their facilities. Initially, some companies expressed surprise at their own toxic chemical release amounts and set goals to improve their environmental performance. TRI data support voluntary pollution reduction efforts at facilities by revealing opportunities for operational changes that reduce releases of toxics. The TRI provides data that corporate managers previously did not have (or did not realize they had), which supports internal initiatives on pollution prevention. TRI data help managers identify and eliminate sources of waste, compare themselves to other similar facilities, and honestly confront the measured performance of their facility (Fung and O'Rourke 2000).

Facilitating Changes in Investor Decisions on Stock Valuation

There is evidence that investors use information created by the Superfund program to monitor environmental management and environmental compliance of companies. Environmental performance has become a common component of many corporate annual reports. In addition, public disclosure of TRI emissions has been increasingly accompanied by coverage in the media and in reports by environmental groups.

Research has established that bad media publicity from TRI-reported releases has a negative impact on stock prices of polluting firms and that those firms subsequently reduce toxic emissions. A study by James Hamilton found that firms releasing high levels of pollution were more likely to be reported in the news media and that publicly traded firms were likely to suffer a decline in stock price as a result of this negative publicity (1995). He reported that stockholders in firms reporting TRI pollution figures experienced negative, statistically significant abnormal returns upon the first release of the information. The lower returns resulted in an average loss of $4.1 million in stock value on the day the figures were released.

Research and analysis by Konar and Cohen similarly found that firms that received more negative media attention to their TRI reports than their peers responded by making greater emission reductions (Konar and Cohen 1997). In addition, research by Khanna et al. suggested that investors could be persistent in their valuation, penalizing firms whose TRI releases have increased over time and rewarding those firms that had made improvements over time (Khanna, Quimio et al. 1998).

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[17] Boeing annual EHS report. 2002.

Information Effect Benefits

EPCRA's primary purpose is to inform communities of chemical hazards in their areas. It appears that local and national environmental groups in the U.S. have embraced the TRI as a means to promote pollution reduction activities. EPA material on the TRI observes that "TRI provides citizens with information about potentially hazardous chemicals and their use so that communities have more power to hold companies accountable and make informed decisions about how toxic chemicals are to be managed."[18] While it has limitations, TRI data, when combined with hazard and exposure information, has been proven to be a valuable tool for risk identification in communities.

The public has used TRI data to identify facilities and chemical release patterns that warrant further study and analysis. Some community organizations have used TRI data to initiate discussions with local industries or to call on public interest organizations to lobby for their causes. For example, the Oneida Environmental Resources Board in Wisconsin used TRI data to convince leaders of the Oneida Tribe to organize a conference on cleaner ways to manufacture pulp and paper (Office of Information and Analysis 2003).

National organizations employ TRI data in many of the same ways as small community organizations, but on a larger scale. National organizations analyze TRI data, use it to conduct risk screening and risk assessment, and often help the public interpret the data. National organizations often work with local public interest and community organizations to initiate discussions between citizens and industry. Some national organizations also use TRI data to help them lobby for changes in national environmental policy (Office of Information and Analysis 2003).

It is important to consider if and how benefits in the *deterrence* category would appear in the policy case (i.e., no Superfund program). A significant amount of deterrence is likely due to related laws, especially RCRA, but there is considerable evidence that TRI and the liability provisions of Superfund create significant deterrents. Therefore, a considerable portion, perhaps most, of the *deterrence* benefits should be assigned to Superfund. Certainly all the benefits discussed above are clearly created by Superfund.

Emergency Preparedness

An important yet poorly-described benefit of Superfund stems from the large scale of its removal program; it allows for a critical mass of resources and expertise necessary to undertake responses at nationally significant hazardous substance problems (U.S. Environmental Protection Agency 1996).[19] In this way, the Superfund program has created a significant portion of the nation's capabilities to respond to certain types of homeland security threats.

The 250 On Scene Coordinators in the ten EPA regional offices, over 40 Environmental Response Team (ERT) staff at the national level, and their supporting consultants are a reserve

[18] EPA 2004. Toxics Release Inventory (TRI) Program Fact Sheet. www.epa.gov/tri/tri_program_fact_sheet.htm. Accessed June 30, 2004.

[19] See www.ert.org/ for more information.

pool of highly trained response personnel available in the event of national emergencies. Also, CERCLA establishes the statutory and organizational framework for response to those emergencies across the federal government, states, and local governments. These structures have allowed Superfund personnel to respond effectively to a broad range of emergencies, from debris recovery after the Space Shuttle Columbia crash[20] to hazardous waste container recovery after hurricanes and other natural disasters.

The large scale of the program allows it to support the ERT at the national level. This is a group of experts who, in addition to supporting the EPA regions in routine removal and remedial actions, have developed expertise to address more unusual situations. For example, they maintain a dive team capable of performing underwater hazardous substance recovery operations. The ERT has been active in all 50 states, all U.S. territories and Commonwealths, and 28 foreign countries. The ERT has responded to more than 6,000 hazardous materials releases, oil spills, and terrorist incidents.

The significance of the benefits of preparedness and expertise, especially in the area of counter-terrorism, is illustrated by Superfund's response following the anthrax attacks on Congress in 2001. Shortly after the discovery of anthrax contamination in the Hart Senate Office Building, EPA was called upon to take whatever steps were necessary to determine the extent of the problems in all the Congressional office buildings and to decontaminate the Hart building. EPA led efforts to take samples and ship them to U.S. Army laboratory at Fort Dietrich for analysis. This type of monitoring and decontamination of anthrax in public buildings had never been attempted previously, and Congress' ability to be fully operational hinged on timely response. Within days EPA and the Army were able to confirm that only the Hart Building posed a threat, allowing the other offices to be reoccupied. Given the unprecedented nature of the decontamination problem, it took a total of three months to identify and test various fumigation options and put them in place. The response needed to be effective without damaging the building, personal property, and papers, and it needed to be safe for surrounding areas. In light of the associated considerations, the response represented a significant accomplishment. It is hard to speculate how long that response would have taken in the absence of the trained Superfund staff and a program designed to address such problems, but it is highly likely that the disruptions would have been much more costly and would have lasted much longer.

Similarly, Superfund had an important role in responding to terrorism at the World Trade Center on September 11, 2001. Within hours, the OSCs and ERT staff were monitoring air and water quality to determine whether they posed residual threats to human health and the environment. EPA staff provided worker health and safety support, making respirators available to all on-scene personnel in the days following the attacks. EPA also worked to remove residual hazardous substances (e.g., fuels) from tanks in the collapsed buildings.

Since 2001, Superfund has continued to expand its counter-terrorism response role by working with the Department of Homeland Security. Depending on the exact nature of a release, it is very likely that Superfund would take the lead in cleanup activities following a terrorist attack

[20] Superfund was called upon due to the possibility that hazardous substances had been released during the breakup of the shuttle on re-entry; no significant releases were subsequently identified.

involving chemical, biological, or nuclear weapons. The removal program's staff is continually applying the type of expertise needed for environmental response to terrorist attacks; thus, a Superfund-led response is efficient. However, the increased training and coordination activities required by the counter-terrorism role are forced to compete for resources with the ongoing removal responsibilities.

It is important to consider if and how the *emergency preparedness* benefit would appear in the policy case (i.e., no Superfund program). Significant emergency preparedness has been gained through the activities of other parts of the federal government, but a large fraction should be assigned to Superfund. Without the Superfund program, the United States would likely have suffered more harm due to some recent terrorist attacks and taken longer to recover.

Information and Innovation

Overview

Superfund benefits in the areas of *information and innovation* stem from three basic efforts: basic research into the toxicology and environmental processes associated with hazardous substances in the environment; epidemiology and health impacts information associated with contaminated sites[21]; and technology innovation and transfer associated with various cleanup methods.

Research

Identifying the specific benefits of basic research poses major challenges for any benefits analysis. The SBA describes the research supported by Superfund, but does not quantify it.

The short-term research efforts most directly applicable to Superfund benefits are those of EPA's Office of Research and Development (ORD), which receives significant budgetary support from Superfund. The ORD's basic research supporting hazardous waste programs includes engineering studies for more efficient treatment systems, health effects studies, transport and fate studies, including those of the subsurface environment, research to improve risk assessments, and ecosystems research (Office of Research and Development 2004).

In the near term (5-10 years), the relevant goals of ORD Superfund research are to:

- Improve the scientific foundation for contaminated sediments remedy selection;
- Provide alternatives to ground water pump and treat remedies;
- Develop tools and methods for assessing and responding to contaminated soils with the goal of returning the land to productive uses; and
- Improve assessment and characterization tools, methods, and models related to multimedia site contamination, human health risk assessment, and innovative technologies.

[21] This benefit is obviously related to ATSDR's site-specific benefits but is differentiated by having a broader set of beneficiaries and having a preventative role as well as a role in mitigation.

ORD plans its Superfund research in conjunction with EPA Superfund headquarters and regional staff so that it addresses the priority needs of the program (Office of Research and Development 2004).

While it is often very difficult to cite specific results of research and development, there are some qualitative benefits that EPA links to earlier research. For example, research and demonstration work on soil vapor extraction in the 1980s led to implementation of a highly cost-effective alternative to excavation and disposal of contaminated soils. Research on bioremediation in the 1980s and 1990s has led to increased applications of this technology for soil, both *in situ* and *ex situ*, and for ground water. Research on bioremediation also led to the development of monitored natural attenuation, which is now widely used for ground water remediation, either alone or in combination with source control, and is recommended as a component of remedies to be selected for contaminated sediment sites. More recent research on source control technologies for dense non-aqueous phase liquids (DNAPLs), such as thermal enhancement and dual phase extraction, is barely reflected yet in the ROD analysis. Similarly, phytoremediation and permeable reactive barriers are showing small increases in application that could accelerate as research and demonstration continue to document the performance and cost savings of these approaches.

In addition to EPA's internal research efforts, the National Institute of Environmental Health Sciences (NIEHS) sponsors the Superfund Basic Research Program (SBRP), which is a federally funded, university-based program, established under SARA. Research funded by SBRP includes developing:

- methods and technologies to detect hazardous substances in the environment;
- advanced techniques for the detection, assessment, and evaluation of the effects on human health of hazardous substances;
- methods to assess the risks to human health presented by hazardous substances; and
- basic biological, chemical, and physical methods to reduce the amount and toxicity of hazardous substances.[22]

These methods, techniques, and technologies can be used by other organizations and individuals (e.g., ATSDR, universities, state agencies, private firms) to advance Information and Innovation yet further, or to create benefits in other categories, such as better (e.g., more effective, or less expensive) response actions, or the sort of site-specific information associated with the community involvement benefit category.

The SBRP emphasizes understanding the factors that affect transport, fate, and transformation of hazardous substances. Research also emphasizes developing remedial action strategies that attenuate and mitigate exposure as necessary to protect human and ecological health. Table 6.3 lists the major areas of research covered under the SBRP.

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[22] Superfund Basic Research Program website, http://www-apps.niehs.nih.gov/sbrp/Index.cfm. Accessed July 2, 2004.

Table 6.3. SBRP Major Research Areas[23]

Research Area	Research Focus
Ecology	Chemical contaminants at Superfund sites affect all living things. Some key areas of Ecology research include studies of how contaminants affect specific species, communities of organisms, and ecological processes (including how contaminants are transferred through food webs). In addition, research looks at how the physiological responses observed in organisms living in contaminated environments can serve as early warning systems for potential adverse human health effects.
Fate and Transport	Fate and transport research is focused on defining contaminant distribution, transport, and transformation on hazardous waste sites. It typically includes extensive field measurements that provide a picture of the extent of contamination at a site. This area of research also includes laboratory studies, which help identify the relevant physical, chemical, and biological processes governing contaminant fate and transport. Another part of this research is the development of advanced numerical, analytical, and statistical models of contaminant fate and transport.
Health Effects	Hazardous substances in the environment can affect human health in a number of ways, such as being suspected or known carcinogens, or being associated with vascular disease, reproductive toxicity, or endocrine disruption. Health effects research includes the following major areas of study: identification of causative agents, determination of the minimum dosages where adverse health effects occur, development of diagnostic tools for detecting chemical agents in biological systems, and discovery of mechanisms by which chemicals cause toxicity.
Risk/Exposure	Risk assessment evaluates the possible effects of Superfund sites on human health, ecosystem health, and the environment. EPA uses this process to view the extent of a problem at a Superfund site and to inform decision makers during various stages of site cleanup. Research includes: epidemiological studies that evaluate the relationship between exposure and disease; the development of new tools, models, and biomarkers to measure exposure and effect; and studies of the environmental pathways in which environmental contaminants are transported from a site to possible points of contact with humans.
Remediation	Remediation research covers the spectrum of technologies (except bioremediation) being developed for the cleanup of all contaminated media. A goal of this research is to develop innovative chemical and physical methods that effectively reduce the amount and toxicity of hazardous substances. Research also examines new and improved methods of hazardous waste containment, recovery, and separation. This area of research also includes laboratory and bench studies, and applied field research.

Knowledge of Health Impacts

In addition to this community-based work, discussed above in the section on Empowerment, ATSDR both performs and funds independent non-site-specific studies of contaminants and their health effects, including maintaining registries of people exposed to hazardous substances in order to study potential long-term health effects. ATSDR then uses the knowledge gained through their activities to educate physicians, scientists, others in the scientific and medical community, and concerned citizens about the risks posed by hazardous substances in general and at specific sites.

[23] Superfund Basic Research Program website, http://www-apps.niehs.nih.gov/sbrp/Index.cfm. Accessed July 2, 2004.

Health-related information is also disseminated through toxicological profiles and Tox FAQs. ATSDR is required under CERCLA to produce toxicological profiles for hazardous substances found at NPL, Department of Defense, and Department of Energy sites. As of 2004, ATSDR reports that 275 toxicological profiles have been published or are under development, covering more than 250 substances.[24] Toxicological profiles are peer-reviewed, and include reviews of current academic literature on toxicological properties of hazardous substances and general chemical information, as well as information about health effects, potential for exposure, and monitoring methods. Toxicological profiles are distributed to health professionals, academics working on issues relating to hazardous substances and human health, and members of the public, including special interest groups. In addition to the toxicological profiles written for chemical and medical professionals, ATSDR has drafted 185 "ToxFAQs," or answers to frequently asked questions about the human health effects of exposure to specific hazardous substances. These include basic information such as how exposure to a hazardous substance can occur, what the health effects of that exposure might be, how to reduce the risk of exposure, and what medical tests can be performed.[25]

ATSDR created and maintains a Hazardous Substance Release / Health Effects Database (HazDat) to provide information on the contaminants present at Superfund and other hazardous sites. HazDat includes information on "site characteristics, activities and site events, contaminants found, contaminant media and maximum concentration levels, impact on population, community health concerns, ATSDR public health threat categorization, ATSDR recommendations, environmental fate of hazardous substances, exposure routes, and physical hazards at the site/event," as well as substance-specific information about the contaminants present and their health effects and data from EPA's CERCLIS database.[26]

ATSDR also maintains a database known as HSEES, the Hazardous Substances Emergency Events Surveillance database, in order to make data publicly available and in order to analyze it and publish the results (Berkowitz et al. 2002; Horton et al. 2003, 2004a, 2004b). Currently fifteen states participate in this surveillance, reporting on the number and characteristics of hazardous substance releases or threatened releases. ATSDR reports that "the goal of HSEES is to reduce the morbidity (injury) and mortality (death) that result from hazardous substances events, which are experienced by first responders, employees, and the general public."[27]

Risk Assessment

As links between toxic chemicals and human health become better known, public health officials are looking for ways to assess the levels of risk in their communities. Toxics Release Inventory (TRI) data have been an important component in creating tools to address these assessments.[28]

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[24] ATSDR's Toxicological Profiles webpage: www.atsdr.cdc.gov/toxpro2.html.

[25] ATSDR's ToxFAQs webpage: www.atsdr.cdc.gov/toxfaq.html.

[26] ATSDR's HazDat webpage: www.atsdr.cdc.gov/hazdat.html.

[27] See www.atsdr.cdc.gov/HS/HSEES/ for more information.

[28] The TRI has also had important impacts in terms of Deterrence, as discussed above.

For example, the New York State Department of Health developed a risk screening protocol using TRI air release data and toxicity potency data to produce relative risk scores and rankings for facilities and chemicals within the state. Results suggested the need for a more careful evaluation of health effects resulting from large releases of non-carcinogenic compounds. In a study of the presence of endocrine disrupting chemicals in the Great Lakes region undertaken by the Environmental Information Center, scientists used TRI data to examine endocrine disrupters released in states bordering the Great Lakes. The study ranked the largest emitters of various classes of toxic chemicals by region.

In addition, the Risk-Screening Environmental Indicators Model, created by EPA's Office of Pollution Prevention and Toxics, provides year-to-year indicators of the potential impacts of TRI chemical releases on human health and the environment.[29] The RSEI tool uses reported quantities of TRI releases and transfers of chemicals to estimate the impacts associated with each type of air and water release by a facility. RSEI considers the amount of chemical released, the location of that release, the toxicity of the chemical, its fate and transport through the environment, the route of human exposure, and the size of receptor populations. It does not serve as a detailed or quantitative risk assessment, but can be used to identify situations where a more formal risk assessment is needed. In addition, both generic and site-specific exposure characteristics can be incorporated. The model allows the targeting and prioritization of chemicals, industries, and geographic areas. Facility scores can be tracked from year to year to analyze trends (Office of Information and Analysis 2003). The tool can also track risk-related results over time as a way to measure progress in environmental protection and pollution prevention programs. The values are for comparative purposes and are meaningful when compared to other values produced by RSEI.

EPA has also used TRI data in creating and implementing the Sector Facility Indexing Project (SFIP). SFIP has been designed to enable the public to access a wide range of environmental information about regulated facilities.[30] SFIP brings together environmental and other information from a number of data systems to generate facility-level profiles for five industry sectors (petroleum refining, iron and steel production, primary nonferrous metal refining and smelting, pulp manufacturing, and automobile assembly) and a subset of major federal facilities. SFIP includes compliance and enforcement information submitted to state and federal regulators, as well as chemical release information submitted under TRI. The SFIP couples emissions data from the TRI with toxicity weighting factors. The result is an index which accounts for both emissions volume and risk in assessing toxic pollution. This information helps to create a better multimedia profile of specific industry sectors and to provide public access to compliance and facility-level information.[31]

Technology Innovation and Transfer

The Superfund program supports a variety of activities to develop and promote innovative technological solutions for hazardous waste problems. Those activities range from establishing

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[29] See www.epa.gov/opptintr/rsei/ for more information.

[30] Note that SFIP benefits people who do not necessarily live near NPL sites, so this benefit is included here and not in the Empowerment category.

[31] EPA 1999. Sector Facility Indexing Project Evaluation. www.epa.gov/sfip/

cleanup technology databases to establishing public/private partnerships that apply new technologies to sponsoring forums for sharing information and results.

Among the databases supporting the technology transfer effort is the Hazardous Waste Clean-up Information (CLU-IN) website, which provides information about innovative treatment technologies to the hazardous substance remediation community. It describes programs, organizations, publications, and other tools for federal and state personnel, consulting engineers, technology developers and vendors, remediation contractors, researchers, community groups, and individual citizens. The site was developed by EPA but is intended as a forum for all waste remediation stakeholders. Another database is the Remediation and Characterization Technology Database (EPA ReachIt), sponsored by EPA, an online database with powerful search options for information on treatment and characterization technologies, plus updated information from remediation projects undertaken by EPA and other federal agencies.[32]

Among various technology demonstration programs is the Superfund Innovative Technology Evaluation (SITE) program established under SARA. The SITE program encourages use of innovative treatment technologies for hazardous substance site response and monitoring. In the SITE program, the technology is field-tested on hazardous substances. Engineering and cost data are gathered on the innovative technology so that potential users can assess the technology's applicability to a particular site. EPA uses the data to assess the performance of the technology, the potential need for pre- and post-processing of the wastes, applicable types of wastes and waste matrices, potential operating problems, and approximate capital and operating costs. The program prepares reports that evaluate all available information on the technology and analyze its overall applicability to other site characteristics, waste types, and waste matrices. Testing procedures, performance and cost data, and quality assurance and quality standards are also presented.[33]

The Environmental Technology Verification (ETV) Program of the EPA develops testing protocols and verifies the performance of innovative technologies that have the potential to improve protection of human health and the environment. ETV was created to accelerate the entrance of new environmental technologies into the domestic and international marketplace. ETV also verifies monitoring and treatment technologies relevant for homeland security. ETV operates through public/private testing partnerships to evaluate the performance of various types of environmental technology in all media: (air, water, soil, ecosystems, waste, pollution prevention, and monitoring). It seeks market input by actively involving technology buyers, sellers, permit writers, consultants, financiers, exporters, and others within each sector.[34]

The Remediation Technologies Development Forum (RTDF) was established after industry approached EPA to identify what they could do together to develop and improve the environmental technologies needed to address mutual cleanup problems in the safest, most cost-effective manner. The RTDF is a public-private partnership created to undertake research,

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[32] For more information, see www.epareachit.org/ , www.epa.gov/swerrims/cleanup/science.htm, and www.clu-in.org/techfocus/

[33] Superfund Innovative Technology Evaluation webpage www.epa.gov/ORD/SITE/

[34] EPA's Environmental Technology Verification (ETV) Program website www.epa.gov/etv/

development, demonstration, and evaluation efforts focused on finding innovative solutions to high priority problems. The RTDF includes partners from industry, several federal and state government agencies, and academia who voluntarily share knowledge, experience, equipment, facilities, and even proprietary technology to achieve common cleanup goals.[35]

The EPA Superfund Environmental Response Team (ERT), which has a key role in responding to national emergencies and in international response, also has a role in testing innovative monitoring and response technologies. The ERT is often called upon where unusual site circumstances present difficult technical or scientific problems. The ERT has been instrumental in promoting broader uses of phytoremediation and *in situ* bioremediation.[36]

This report has not attempted to identify all the benefits resulting from the technology transfer efforts, but some specific benefits are noted. According to EPA's Office of Research and Development, private sector environmental technologies have been verified in such areas as drinking water systems for small communities, air pollution control technologies that reduce smog-causing NO_x and lower greenhouse gases, new technologies that lower emissions and costs for metal finishing shops and industrial coatings operations, and innovative monitoring technologies of all types.[37]

It is important to consider if and how the *information and innovation* benefit would appear in the policy case (i.e., no Superfund program). Considerable evidence supports the claim that government action is necessary to encourage socially desirable levels of research and development for knowledge and technologies that are primarily associated with public goods, such as the environment (Skea 1996; Jaffe and Palmer 1997; Azar and Dowlatabadi 1999; Margolis and Kammen 1999; Norberg-Bohm 1999; Kerr and Newell 2001; Jaffe et al. 2002; Taylor et al. 2003). Thus, in the absence of the Superfund program, much or all of the activities discussed above would likely not have been undertaken. Therefore, much or all of the benefits associated with information and innovation should be assigned to the Superfund program.

International Benefits

The Superfund program staff support the U.S. diplomatic and humanitarian efforts internationally, especially by training and direct response actions.[38] For example, experts from the ERT provided air monitoring over the burning oil fields of Kuwait after the first Gulf War to support the firefighting teams who responded to those fires. The ERT in particular has provided direct response support in 28 countries, ranging from Cameroon to Vietnam. Through EPA's Office of International Activities, Superfund staff has provided training to a number of countries in such areas as preparedness, incident response, site assessment, and chemical safety audits. Superfund staff trained their counterparts in Eastern Europe to support them in establishing hazardous waste response programs after the dissolution of the Soviet Union.

[35] Remediation Technologies Development Forum website www.rtdf.org

[36] From ERT's website, http://www.ertresponse.com.

[37] For more information see the EPA's ETV program website www.epa.gov/etv/

[38] CERCLA limits the use of the Trust Fund to domestic expenditures; significant expenditures to pay for Superfund staff working on international projects would be funded under other appropriations (e.g., under interagency agreements with the U.S. State Department).

It is important to consider if and how the *international* benefit would appear in the policy case (i.e., no Superfund program). The Superfund program provides only the technical capabilities, but not the statutory or budgetary support for International benefits. For the most part, these capabilities are already covered by other benefit categories, so the amount of the international benefit category that should be attributed to Superfund is slight.

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